

Clarification of Risk Factors for Abdominal Operations in Patients with Hepatic Cirrhosis

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Celiotomy in cirrhotic patients is reported to bear a high risk of operative morbidity and mortality. We reviewed 100 consecutive, cirrhotic patients who underwent nonshunt celiotomy. Thirty patients died and major complications occurred in another 30 patients. Hospital mortality rate was 21% in 39 biliary operations, 35% in 26 procedures for peptic ulcer disease, and 55% in nine colectomies. Fifty-two variables were compared between survivors without complication, survivors with complications, and nonsurvivors. A computer-generated, multivariate discriminant analysis yielded an equation predictive of survival. Utilizing coagulation parameters, presence of active infection, and serum albumin, the equation predicted survival with 89% accuracy. In a similar fashion, amount of operative transfusions, absence of postoperative ascites, pulmonary failure, gastrointestinal bleeding, and culture-positive urine predicted survival with 100% accuracy. We conclude that celiotomy in the cirrhotic patient is truly associated with very high morbidity and mortality, and preoperative assessment can predict survival with 89% accuracy.

PATIENTS WITH HEPATIC CIRRHOSIS frequently require an abdominal procedure. It has been estimated¹ that ten per cent of all patients with liver disease undergo operative procedures during the final 2 years of their lives, when they represent the least satisfactory surgical risks. Furthermore, many investigators²⁻¹¹ have documented a high risk of morbidity and mortality associated with abdominal procedures in this group of patients. It is important to have a tool to assess the risk of operation in cirrhotic patients before surgery. Many studies have attempted to predict operative mortality by assessing variables in patients undergoing portasystemic shunt procedures. Several of these authors¹²⁻¹⁴ have proposed multifactorial indices to more accurately estimate surgical risks. Child's classification remains the most successful.

On the other hand, there is a lack of data concerning the estimation of surgical risk in cirrhotic patients un-

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dergoing nonshunt celiotomies. Stone¹⁵ has suggested that the Child's classification is useful in predicting the outcome of any major surgical procedure although no data were presented in his paper to support this conclusion. Pugh et al.¹⁶ proposed a modification of the Child's classification, adding prothrombin time to replace the nutritional assessment in a series of patients undergoing transection of the esophagus with bleeding esophageal varices. In addition, several surgeons^{2,3,5,11} have reported various preoperative variables that correlate with the high operative mortality in the cirrhotic patient. However, Jackson¹ concluded that the prognosis for survival in cirrhotics cannot be predicted with current methods of evaluation and that the ultimate outcome in an individual patient is not easily determined prior to the procedure.

The purpose of this study was to further document the operative morbidity and mortality associated with an abdominal procedure in cirrhotic patients. An additional objective was to utilize a computer-generated multivariate discriminant analysis to devise an equation for the accurate, preoperative assessment of operative risk.

Patients and Methods

One hundred consecutive patients with liver cirrhosis who underwent a celiotomy at University Hospital (Louisville General Hospital) and the Veterans Administration Medical Center in Louisville, Kentucky, between 1975 and 1982 were retrospectively reviewed. No patient who underwent a portasystemic shunt or who had previously undergone that procedure was included in this review. Fifty-four preoperative, operative, and postoperative variables were listed for each patient and catalogued for three patient groups: survivors without postoperative complications, survivors with postoperative complications, and nonsurvivors.

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Preoperative data listed included age, sex, coexisting medical disease, mode of presentation for the underlying operative disease, and the presence of encephalopathy, malnutrition, ascites, and concomitant infection or peritoneal contamination. Malnutrition was listed as present only if so stated in the medical record. Ascites was considered present if noted before surgery or documented during the surgical procedure. Preoperative serum enzymes, albumin and bilirubin levels, coagulation parameters, and hematologic values were similarly recorded. Operative data listed included the operative procedure, its duration, transfusion requirements, and the use of all drains or tubes that exited the peritoneal cavity. Postoperative variables noted were mortality and morbidity, length of hospital stay, the development of positive bacterial cultures or subsequent organ system failure, and antibiotic treatments.

All patients had proven cirrhosis from either a previous biopsy or one taken at the time of the operation. Each patient was assigned a Child's classification based on the most recent laboratory data and progress notes prior to the procedure. Pulmonary failure was defined as ventilator dependence for 5 days or more. If the patient was overtly oliguric or the serum creatinine exceeded 2 mg/dl, renal failure was considered present. Liver failure was defined as a total serum bilirubin level greater than 2 mg/dl with a concomitant doubling of the liver enzyme levels over normal values. Gastrointestinal failure was defined as gastrointestinal bleeding that required the transfusion of two or more units of blood products within a 24-hour period, or endoscopic evidence of bleeding. A decrease in cardiac output requiring pharmacologic support when the vascular volume was normal constituted cardiac failure.

The occurrence of each variable within patient groups was subjected to statistical analysis by chi square for categorical variables and analysis of variance for continuous variables. All 54 variables except Child's classification were then included in a stepwise multivariate discriminant function analysis. An equation was derived to predict survival. A total of 66 patients with complete data was included in this analysis. The discriminating equation that this analysis developed was tested on all patients in the study and the accuracy of the prediction evaluated. One equation for prediction of survival was derived for all preoperative variables and a second equation for operative and postoperative variables.

Results

A total of 100 consecutive patients, 30 women and 70 men, with hepatic cirrhosis underwent a nonshunt celiotomy during the period of review. Thirty patients died during the postoperative period. An additional 30 patients

survived although they suffered at least one major complication. Forty patients survived without complications. Sepsis with multiple organ system failure was the cause of death in 26 patients (87%) while bleeding accounted for two deaths (7%). One death was attributed to metastatic carcinoma and the last to methanol poisoning.

A variety of abdominal procedures were performed. Thirty-nine biliary tract procedures constituted the largest single group and resulted in mortality in eight patients. A cholecystectomy alone was performed on 29 occasions with a mortality rate of 17% while an additional ten patients underwent a choledochotomy with three deaths resulting. The second most common indication for operation was a complication of gastroduodenal ulcer disease. Perforation of the ulcer was the listed cause for exploration in 11 patients and five of these died. Four deaths were noted in 12 patients with bleeding as the indication for operative intervention. Two patients required correction of gastric outlet obstruction and one patient was explored for gastric lymphoma. A total of 26 patients underwent an operation on the gastroduodenal complex with a mortality rate of 35%. Nineteen of these procedures were performed as emergencies and all nine deaths occurred in this subset.

Nine patients underwent colon resection resulting in five deaths. Perforated diverticuli required emergency operation in four patients and accounted for three deaths. Three patients underwent an elective colectomy for carcinoma and one death resulted. The last death in this group occurred in a trauma patient who underwent exteriorization of a colon injury.

Five patients underwent open liver biopsy for the diagnosis of metastatic carcinoma with one death attributed to the metastatic disease. Five additional patients underwent a negative exploratory laparotomy with four resultant deaths. An exploration had been initiated to search for a correctable source of infection in a septic patient with multiple organ system failure in each of these deaths. The lone survivor in this group was a patient with a preoperative diagnosis of a pancreatic pseudocyst who was found to have only a loculated collection of ascites.

Five patients had small bowel procedures. Small bowel obstruction required lysis of adhesions in two patients, while two others needed small bowel resections for strangulated inguinal hernias; these latter two patients died. An additional patient had a jejunal resection for a bleeding arteriovenous malformation and later died. Three patients required exploration for trauma and two deaths occurred in patients with liver and splenic bleeding. Various pancreatic, splenic, and vascular cases accounted for the remaining procedures with one death noted. Although operative indications and procedures showed wide differences in mortality, these were not statistically different between large groups.

TABLE 1. Preoperative Variables Differ Between Groups

Preoperative Variable	Survivors		Nonsurvivors
	Without Complications	Complications	
	(n = 40)	(n = 30)	(n = 30)
Ascites present*	12.5%	33%	70%
Malnutrition present*	7.5%	16.7%	43%
Emergency procedure*	15.0%	40%	80%
Active infection present*	7.5%	16.7%	47%
Bilirubin mg/dl mean†	1.2 ± 0.2	2.0 ± 0.5	4.1 ± 1.0
Albumin g/dl mean†	3.7 ± 0.6	3.3 ± 0.2	2.5 ± 0.1
WBC 10 ³ mean†	8.3 ± 0.6	9.5 ± 1.3	14.5 ± 1.8
PT > Control seconds mean†	+0.3 ± 0.3	+1.5 ± 0.6	+4.5 ± 1.0
PTT > Control seconds mean†	-3.0 ± 0.8	-0.8 ± 2.2	+7.9 ± 2.4
Child's class mean†	1.25 ± 0.1	1.6 ± 0.1	2.4 ± 0.14

* p < 0.01 by chi square.

† p < 0.01 by analysis of variance.

All 54 preoperative, operative, and postoperative variables were subjected to statistical analysis. Preoperative variables that were found to be different ($p < 0.01$) between survivors without complications, survivors with complications, and nonsurvivors are listed in Table 1. All preoperative variables except Child's classification were then subjected to multivariate stepwise discriminant analysis. Those variables found to be significant in discriminating between survivors and nonsurvivors are listed in Table 2 in decreasing order of importance. An equation was then generated to predict survival using all preoperative variables. In formulating this equation, the computer program first picks the one variable that is most discriminatory between survivors and nonsurvivors. Each successive variable for the predictive equation is chosen in a stepwise fashion. The variable picked adds the most information in discriminating between the two groups without overlapping information supplied by the previous variables used in the equation. When no further discrim-

ination can be obtained by the addition of further variables, including those not statistically significant between groups, a coefficient is derived for each variable. The coefficients give appropriate weight to the variable in the equation. Utilizing the variables and coefficients found to be of value in predicting survival and nonsurvival, the equation was solved for each of the patients in the study, and group means were computed for the survival group and the nonsurvival group.

The equation and variables found to be of value along with their coefficients are illustrated in Table 3. An equation was derived utilizing the three preoperative variables of albumin (preoperative value), infection/contamination (yes = 1, no = 2), and the difference in seconds between the actual value and the control value for the partial thromboplastin time. Infection/contamination refers to active intra-abdominal infection or contamination from perforated viscus. The equation for all three preoperative variables is: $-4.90019 + [(\text{albumin} \times 0.86204) + (\text{infection} \times 1.23263) + (\text{PT-PTTc} \times -0.05189)]$.

The group mean closest to the value for each patient determined the group in which the patient belonged. It was found that, of these patients with values more negative than the group mean for nonsurvivors, 93% died and, of the patients with values more positive than the group

TABLE 2. Preoperative Variables Differ Between Survivors and Nonsurvivors

Variable	Mortality if Variable Present	Mortality if Variable Absent
Child's classification		
A	10%	50%
B	31%	30%
C	76%	18%
Ascites	58%	11%
Infection/contamination	64%	21%
Emergency procedure	57%	10%
Poor nutrition	62%	22%
Bilirubin ≥ 3 mg/dl	62%	17%
Albumin < 3 mg/dl	58%	12%
PT > Control	47%	7%
PT > 1.5 sec/control	63%	18%
PTT > Control	54%	18%
WBC > 10,000	54%	19%

p < 0.01 for all variables listed.

Listed in order of decreasing importance in predicting survival.

TABLE 3. Preoperative Variables: Multivariate Discriminant Analysis*

Variable	Coefficient
Albumin (preoperative value)	0.86204
Infection/contamination (yes = 1, no = 2)	1.23263
PT-PTT control (preoperative values)	-0.05189
Constant = -4.90019	

* Equation: Patient score = constant + Z (variable coefficient \times variable value).

Group	Means
Survivors	0.62527
Nonsurvivors	-1.33986

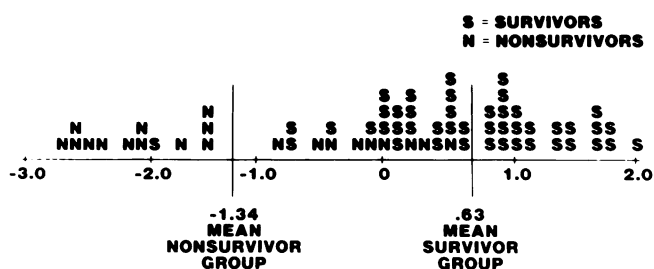


FIG. 1. Preoperative variables: accuracy of predictive equation. All patients with values greater than the group mean for survivors lived. Ninety-three per cent of patients with values less than the group mean for nonsurvivors died. Patients with values between the means were classified correctly 66% of the time.

mean for survivors, 100% lived. This is illustrated in Figure 1. Patients with values between the two means were predicted accurately 66% of the time. Overall, the equation predicted survival with 90% accuracy and nonsurvival with 71% accuracy. Accumulative accuracy of the entire equation in predicting survival or nonsurvival was 83% (Table 4).

All operative and postoperative variables were then analyzed in a similar fashion. Those variables found to be different between survivors and nonsurvivors are listed in Table 5 in order of decreasing significance with respect to predicting outcome. Transfusion requirements were the only significant operative variable found to contribute to this prediction. All operative and postoperative variables were then subjected to multivariate stepwise discriminant function analysis in a fashion similar to the previous analysis. Pulmonary failure, operative blood transfusion requirements, stress gastrointestinal bleeding, urinary tract infection, and the development of ascites in the postoperative period were selected as most predictive of outcome. These variables with their coefficient weights and the means for each group are listed in Table 6. Overall, when tested against patients in our study, this equation predicted outcome with a 98% accuracy (Table 7).

Discussion

Celiotomy in the cirrhotic patient has been reported to carry a high risk mortality.^{2,3,5,8,9} In reviewing 100 patients with histologically proven cirrhosis undergoing nonshunt celiotomy, we confirmed this finding with an

TABLE 4. Preoperative Variables: Accuracy of Predictive Equation

Group	Correct (%)	No. of Survivors	No. of Nonsurvivors
Survivors	89	40	5
Nonsurvivors	71	6	15
Total	83	46	20

TABLE 5. Operative and Postoperative Variables Differ Between Survivors and Nonsurvivors

Variable	Mortality if Variable Present	Mortality if Variable Absent
Pulmonary failure	100%	0%
Cardiac failure	92%	8%
Antibiotics > 2	82%	10%
Renal failure	73%	9%
Liver failure	66%	8%
Infected ascites	85%	16%
Ascitic leak	82%	18%
GI bleed	86%	21%
Positive sputum culture	58%	18%
Required secondary operation	81%	20%
>1 course antibiotics	73%	21%
Postoperative bleeding	100%	26%
Positive urine cultures	65%	22%
Positive blood cultures	61%	21%
Wound infection	61%	22%
Blood > 2 units	69%	22%
Fresh frozen plasma	61%	19%

$p < 0.01$ for all variables listed.

Listed in order of decreasing importance in predicting survival.

overall operative mortality of 30% and an additional morbidity rate of 30%. Sepsis with multiple system organ failure was by far the most common cause of death and seen in 87% of our failures. In an attempt to explain this extraordinarily high mortality rate, we analyzed multiple preoperative, operative, and postoperative variables. Stepwise multivariate discriminant analysis was utilized to determine which variables were most predictive of outcome.

Neither the organ system involved in the surgical procedure nor the operative procedure performed was helpful in predicting survival, although the presence of intra-abdominal infection or contamination from a perforated viscus contributed significantly to a poor outcome. Infection/contamination was associated with a 64% mor-

TABLE 6. Operative and Postoperative Variables: Multivariate Discriminant Analysis*

Variable	Coefficient
Pulmonary failure (yes = 1, no = 2)	5.23786
Blood requirements (number of units)	-0.14948
UGI bleed (yes = 1, no = 2)	1.46929
Urinary infection (yes = 1, no = 2)	-0.53948
Ascites development (yes = 1, no = 2)	-1.39626
Constant = -8.74144	

* Equation: patient score = constant + Z (variable coefficient \times variable volume).

Group	Means
Survivors	1.62694
Nonsurvivors	-3.87098

TABLE 7. Postoperative Variables: Accuracy of Predictive Equation

Group	Correct (%)	No. of Survivors	No. of Nonsurvivors
Survivors	100	70	0
Nonsurvivors	93	2	28
Total	98	72	28

tality rate compared to 21% when it was not present. Operative urgency was similarly related to mortality. Death occurred in 57% of the patients who underwent surgical treatment on an urgent basis compared to only 10% mortality on an elective basis. These findings are consistent with those of Doberneck et al.⁵ Their study found a mortality rate of 45% for emergency procedures, while only 11% of elective operations had a similar outcome in nonbleeding cirrhotic patients. Child's classification was related to the operative mortality. Mortality rate in 50 Class A patients was 10 per cent, increased to 31% in 29 Class B patients, and was found to be 76% in 21 Class C patients. Furthermore, each of the components of the Child's classification was found to be statistically different between these groups with the exception of encephalopathy, which in our series was poorly documented in the hospital records reviewed. Stone¹⁵ has reported that although the Child's criteria were initially written to predict the operative risk of patients undergoing portosystemic shunt procedures, they are equally useful in predicting the outcome of any major surgical procedure. Furthermore, elevated bilirubin, hypoalbuminemia, and the presence of ascites have been found to be different between survivors and nonsurvivors in studies by other authors^{5,16} reporting on nonshunt celiotomy in cirrhotics.

Coagulation parameters had a similar bearing on survival in our study. When the prothrombin time was greater than that of control, 47% of all patients died compared to only seven per cent when the prothrombin time was less than or equal to the control value. If the prothrombin time of the patient was greater than 1.5 seconds over control time, the mortality rate increased to 63%. These findings are consistent with reports by other authors^{2,9} who found that prolonged prothrombin time was related to mortality in a significant way. Aranha² found prothrombin time to be the variable most predictive of survival.

Our analysis listed white blood cell counts of greater than 10,000 as associated with a high mortality rate of 54% compared to only 19% when this count was less than 10,000. This finding is consistent with the fact that intra-abdominal infection or contamination is the leading contributor to mortality in our patients. All other preoperative factors that we reviewed, including the number of pre-existing diseased organ systems, were not significantly

different between survivors and nonsurvivors in our patients.

The only operative variable related to mortality was the transfusion requirement. When operative transfusions of more than 2 units of blood were required, the mortality rate of 69% was observed compared to only 22% when 2 units or less were required. Similar findings were seen with fresh frozen plasma replacements; operative mortality of 61% occurred when these transfusions were needed compared to only 19% when none was required. These findings were expected and were simply an extension of the preoperative coagulation parameters.

We think it is interesting that drain use was not statistically different between survivors and nonsurvivors. In patients with ascites present, the usage of drains compared to their nonuse led to mortality rates of 53% and 65%, respectively. However, drains did play an important role leading to mortality in patients who developed an ascitic leak. In 10 of 26 patients dying from sepsis, the source of the infection was judged to be secondary to infection of ascites following the development of an ascitic leak. In seven of these ten patients the leak developed from a drain site, and in six patients the organisms cultured, *Staphylococcus* and *Streptococcus*, suggested contamination from outside the peritoneal cavity.

Mortality rates for various operative procedures were high and not statistically different between larger groups. Procedures performed on the biliary tract had a 21% mortality rate in our series, which compares favorably to several recent studies. Schwartz⁹ reported a mortality rate of 27%. Aranha² confirmed this finding with a rate of 26% of cirrhotic patients undergoing cholecystectomy. Patients undergoing operation for the complications of peptic ulcer disease were found to have an operative mortality rate of 35%. This percentage again compares favorably with the 57% mortality rate reported by Wirthlin¹¹ in cirrhotic patients undergoing procedures for nonvariceal upper gastrointestinal bleeding. The rate from our study also correlates with the 23% mortality rate reported by Doberneck⁵ for nonbleeding cirrhotic patients undergoing resection or repair of the gastrointestinal tract. Fifty-three per cent of the patients undergoing a colon resection in our series died. To our knowledge, there are no other reports of colectomy in this patient population. The remainder of our patients underwent a variety of abdominal surgical procedures. Although the number of patients undergoing each individual procedure was small, the overall mortality rate in this group was 31%, which is consistent with the overall mortality percentage seen in our study.

Morbidity was also high in our study. Eighty-five postoperative complications occurred in 30 surviving patients. The majority of these complications were related to infection. By far, the most common cause of death in our

series was sepsis with multiple organ system failure accounting for 87% of the deaths. This finding is consistent with separate reports by Schwartz⁹ and Aranha,² where sepsis accounted for 33% of mortalities in each of those studies. The subsequent development of multiple organ system failure was linearly related to mortality. The mortality rate was only two per cent if no organ systems failed, nine per cent if one organ system failed, 50% if two organ systems failed, 75% if three organ systems failed, and 100% if four or more organ systems failed. Furthermore, if pulmonary failure complicated the postoperative course, a mortality rate of 100% was noted.

Several investigators have developed formulas for predicting operative risk in cirrhotic patients undergoing procedures other than portasystemic shunts. In 1955, Cayer³ found that the mortality rate in cirrhotic patients with ascites undergoing a variety of operations was 50% and that ascites, hypoalbuminemia, prolonged prothrombin times, and anemia were different between survivors and nonsurvivors. Wirthlin¹¹ found that the preoperative serum bilirubin level was the most reliable indicator for poor surgical risk in cirrhotic patients undergoing procedures for nonvariceal upper gastrointestinal bleeding. The presence of varices with past history of ascites, elevated serum ammonia levels, prolonged prothrombin time, and hypoalbuminemia were all significant between survivors and nonsurvivors. He developed a five-point scoring system to assess surgical risk. Stone¹⁵ found that the Child's classification criteria were useful in predicting the outcome of any major procedure in the cirrhotic patient. Pugh¹⁶ utilized a modification of the Child's classification by substituting prothrombin time for nutrition. He developed a point system that predicted operative mortality in a series of patients subjected to transection of the esophagus for bleeding esophageal varices. Doberneck⁵ reported 102 nonbleeding cirrhotic patients undergoing an operative procedure. He found that an increased mortality rate was associated with the following: a serum albumin level greater than 3.5 mg/dl, an elevation of alkaline phosphatase values, prothrombin time greater than 2 seconds/control, an emergency procedure, an alimentary tract operation, the presence of ascites, operative blood loss of more than 1000 cc, and postoperative complications. Doberneck also found that the number of significant risk factors present was predictive of operative mortality ranging from five per cent for zero to one factor up to 67% when more than six factors were present. On the other hand, Jackson¹ concluded that the prognosis for survival in cirrhotics could not presently be predicted in clinical, laboratory, or physiologic studies alone. He found that the ultimate outcome in the individual patient is not easily determined prior to operation.

We found ten preoperative variables that were different

($p < 0.01$) between survivors and nonsurvivors in our study. These included Child's classification, elevated serum bilirubin, hypoalbuminemia, the presence of ascites, malnutrition, active infection/contamination, an elevation of the white blood cell count, prolongation of the prothrombin time, prolongation of the partial thromboplastin time, and the need for an emergency procedure. However, when all preoperative variables were subjected to stepwise multivariant discriminant functional analysis, only three variables were utilized to predict the outcome of patients in our series. We excluded Child's classification as a predictor of survival as it represents a multivariant formula in itself.

The final equation, thus generated by our analysis, utilized only three preoperative variables in predicting the outcome. These variables were the absolute serum albumin concentration, the presence of infection/contamination, and the number of seconds partial thromboplastin time deviated from its control value. The equation predicted *survival* with 89% accuracy and predicted *nonsurvival* approximately 71% of the time. An overall accuracy rate of 83% was noted. A series of variables can be selected utilizing this technique, each of which supplies information to the predictive equation but does not overlap with the information supplied by the previous variables in the equation. Similar techniques have been utilized by Irvin and Zeppa¹⁷ for peptic ulcer disease and by Simert¹⁰ and Cello⁴ for portasystemic shunt procedures. This equation is expected to be accurate since it was derived from the patients upon whom it was tested. We are currently undertaking a prospective analysis of its predictive value as well as a retrospective study upon patients cared for in other university-affiliated hospitals.

In a similar manner, the operative and postoperative variables were subjected to the stepwise discriminant function analysis. The variables chosen by the computer in the development of the equation were pulmonary failure, operative blood transfusion requirements, gastrointestinal bleeding in the postoperative period, the development of a positive urine culture, and finally, the development of ascites. When applied to the patients in our study, this equation predicted survival with 100% accuracy and nonsurvival with 93% accuracy. This predictive equation using postoperative data is not useful as a tool in itself. However, it does demonstrate a combination of factors that lead to mortality in our patients. The equations suggest that, if these factors can be prevented or altered, the chance for survival for the patient may be improved.

Conclusions

Operative risk for procedures other than portasystemic shunts in cirrhotic patients is high. In our series, an overall

mortality rate of 30% was noted with an additional 30% morbidity rate in surviving patients. This unacceptable rate of death is consistent for all groups of operative procedures.

Analysis of operative and postoperative factors leading to a mortality identifies multiple problems that must be solved to decrease this operative mortality rate. These obstacles include normalization of coagulation parameters, improvement in nutritional status, and control of preoperative ascites.

Preoperative assessment can predict survival with approximately 90% accuracy in cirrhotic patients requiring abdominal procedures. Multivariant stepwise discriminant analysis may be a useful tool in developing equations to predict operative risk from variables assessed before surgery for a variety of high risk procedures.

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DISCUSSION

DR. ROBERT ZEPPA (Miami, Florida): We are indebted to Dr. Polk and his colleagues for an elegant study that has sought to quantify those variables that predict survival or the lack thereof in a group of high-risk patients. The importance of this contribution can not be overestimated. It is only when, as the authors have done, you obtain quantitative information concerning the predictive value of a finite and manageable group of patients—can you then do prospective studies of logical preoperative and postoperative therapeutic interventions that perhaps will lower the horrendous mortality that has been demonstrated here.

The analysis of the postoperative mortality clearly demonstrates that this high-risk cohort of patients will not tolerate a complication. Further, if these are anticipated, or can be anticipated, as demonstrated by Dr. Polk's data, then perhaps a therapeutic game plan can be directed toward the prevention of these sorts of complications and/or earlier intervention when the clues that have been accumulated by the data collection suggest that they are about to occur.

The data presented suggest that, at least in elective patients, as much preoperative physiological data should be obtained, and the deficits demonstrated as a function of the collection of these data corrected, before surgery.

It is most intriguing to me to compare these data with those we have observed in our nonalcoholic cirrhotic population who have been subjected to shunts. In our analysis of 91 patients with nonalcoholic cirrhosis who were operated on between July 1971 and July 1981, 22% of the group were on steroid therapy for chronic, aggressive hepatitis; this, of course, is associated with hyperbilirubinemia and disturbances in the hepatic circulating enzymes. Yet the operative mortality for this group was only 4%, and these are major operations.

Two questions: Were your cirrhotic patients all alcoholic in this particular series? And in the utilization of the Child categorization, how many of the variables needed to be present before you moved the patient from Group A to Group B to Group C?

DR. WARD O. GRIFFEN, JR. (Lexington, Kentucky): It is clear that the authors have done a magnificent job of identifying preoperative, operative, and postoperative risks in these patients and showing the ones that are important.

The reason I asked to discuss the paper was on account of a patient that one of our senior residents, Dan Procter, and I took care of last year, doing a straightforward left hemicolectomy for cancer in a patient with cirrhosis, who died 42 days later of sepsis. I asked him to look up our cases of colectomy in patients who were cirrhotic.

In a 5-year period of time, he found six such patients, and three of the six patients died, all of them of sepsis. They had the same features that Dr. Polk has indicated already. The three nonsurvivors all had ascites at the time of the operation; one had contamination from a perforation of her diverticular disease. They all had intra-abdominal anastomoses made.

I wonder, and I ask the authors: Would it be possible to reduce the risk, at least in the patients undergoing colon resection who are cirrhotics, by avoiding an intraperitoneal anastomosis?

I do not know the answer to that, but I wonder if that is possibly an added risk. In other words, if you do colostomy and forget about trying to put the bowel back together, it might provide you with more survivors.

DR. WILLIAM J. MILLIKAN (Atlanta, Georgia): The Emory surgical liver group appreciates the opportunity to review this manuscript, and we feel that this will come to be recognized as a major contribution to the field of liver disease.

Second, we appreciated the opportunity to review the manuscript with our biometrist back in Atlanta, because this paper has so much data that unless you have the opportunity to review the manuscript, a lot of it gets lost in the slides.

We would like to make two points that we relearned from the paper, and ask two questions.

(Slide) In a paper that was presented here in this room 2 years ago, Dr. Warren presented the Emory 10-year experience with patients op-